Design and Implementation of a Geographic Information System for the General Practice Sector in Victoria, Australia

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Abstract

This paper details a collaborative research project to develop a geographic information system (GIS) for two diverse administrative areas of general medical practitioners in Victoria, Australia. The study is one of a small number of initiatives in the use of geospatial information and application of GIS technology to the health sector in Australia. Australia's use of divisions of general practice is described, depicting the role of divisions in improving the health of the Australian population. An outline is given of the role of data and information technology in improving effectiveness and efficiency in the operation of these divisions. The paper describes the methodology of the pilot project, which was aligned to the divisions' needs and future directions. Data were drawn from routinely collected demographic, health, and road network datasets; the datasets themselves came from local, state, and federal sources. Additional data were collected using a questionnaire that profiled general medical practices. The rationale for using the Internet to present the GIS prototype is given. The paper also presents a range of data analysis that depicts the role of this integrated information in identifying strategic decision-making and further research possibilities. This project demonstrates the potential of a GIS, with its ability to answer spatial questions and illustrate spatial relationships, to assist in decision-making in local health areas. Routine collection of morbidity and treatment information at the general practice level would enhance data quality at that level. The methodology and outcomes of this project are serving as a springboard to broader interest in the uptake of GIS in the health sector, given the diversity and widespread location of the population.

Keywords: general practice, service planning, Australia

Introduction

This paper details a collaborative research project to develop a geographic information system (GIS) for two diverse administrative areas of general medical practitioners in Victoria, Australia. The study is one of a small number of initiatives in the use of geospatial information and application of GIS technology to the health sector in Australia. The paper first briefly describes Australian initiatives in GIS and health, and sets the scene of this particular study. The paper then describes the methodology of the

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pilot project, which was aligned to the end users' needs and future directions, and details data sources and a range of data analysis. Finally, the outcomes of the project are highlighted and ongoing aspects of the research identified.

Overview of Australian Initiatives in GIS and Health

Over the last decade, interest has increased in initiatives to make the best possible information available to health and community service providers at the national, state, and local levels. To date in Australia, spatial health research has concentrated more on analyzing health care service needs for purchasing and planning, and less on patterns of disease distributions or what is more commonly known as geographic or environmental epidemiology. GIS is most commonly used across the Australian health sector within a social health framework. Because of this, using GIS has involved integrating data collections such as socioeconomic and specific health datasets of hospital admission rates, mortality, and birth events. Examples in Australia include the study of possible relationships between locational disadvantage and uptake of health services (1); emergency services dispatch developed by the Intergraph Corporation in the state of Victoria; drug research and harm reduction strategies (2); the South Australian Health Commission Social Health Atlas (3); and the National Social Health Database, known as HealthWIZ (4), which contains local-area health data on deaths, population characteristics, cancer registry details, social security, and Medicare, the Australian universal public health financing system.

Current reforms in Australia have redefined funding formulae for the health system. This has, in turn, caused a growing recognition of the importance of decision-making tools like GIS.

GIS for General Practice Project

This particular project is the result of a willingness to improve communication, information technology, and information management between the state-funded health services and the federally funded primary care infrastructure of family doctors (general practitioners, commonly known as "GPs"). Groups of GPs were brought together in recent years to form "divisions of general practice," a relatively new organizational structure designed to enable GPs to work together and to work within the wider health care system, to improve the quality of care, to meet local health needs, to promote preventive care, and to respond rapidly to community health needs. There are 118 divisions in Australia, with a median population of 152,920 per division (5). The Victorian state health department (known as the Department of Human Services) committed funds to develop and implement a prototype GIS as a tool for planning, education, and research in relation to the health needs and health status of the population groups within each division.

Project Team

The research team involved in this project includes the Centre for Community Child Health (University of Melbourne, Royal Children's Hospital, Melbourne), the Department of Geomatics, University of Melbourne, and the National Key Centre for

Social Applications of GIS, University of Adelaide. The project also received support from Land Victoria, Department of Natural Resources and Environment.

The Centre for Community Child Health plays a national role in child health education and research across the range of health professions, including general practice. The University of Melbourne's Department of Geomatics conducts education and research on a wide variety of GIS topics and plays an important role in the diffusion of GIS technology, assisted by Land Victoria, which deals with geospatial policy and geospatial datasets. The National Key Centre for Social Applications of GIS, as its name suggests, has expertise in the application of GIS technologies to social and community planning programs.

Instrumental partners in the project have been the two divisions of general practice for which the project was developed. Both of these divisions are in Victoria, a state in southeast Australia. One division is in northwest Melbourne, an inner metropolitan area of Victoria's capital city (Figure 1). The northwest Melbourne division has 234 of the 436 GPs known to be practicing in that geographic area (membership in a division is voluntary). The total population is 281,856 persons (6), giving a GP-to-person ratio of 1:646.

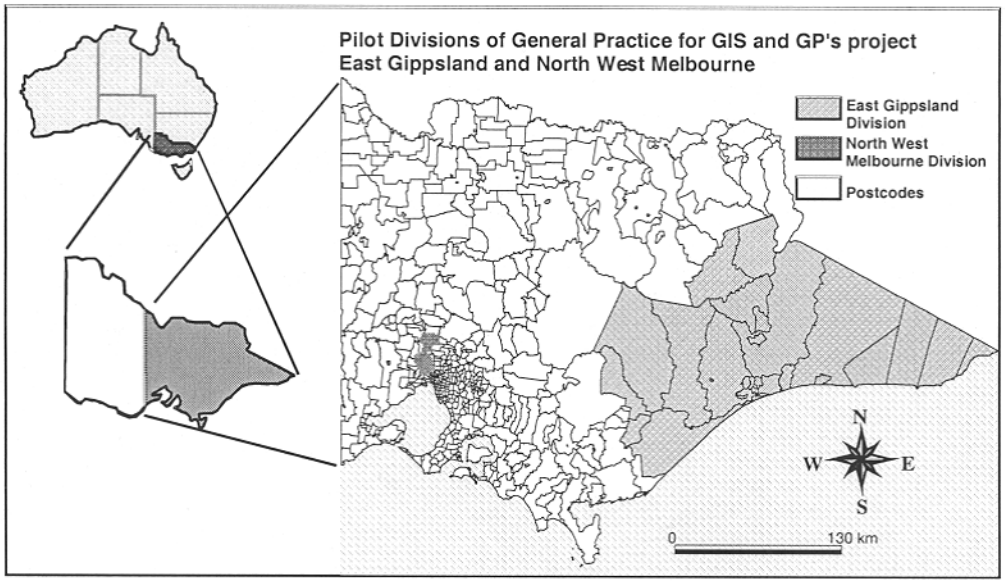

Figure 1 Pilot divisions of general practice, Victoria.

The second division is located in East Gippsland, a rural, coastal area in the southeast of Victoria that covers 12.5% of the state. The East Gippsland division of general practice is situated approximately 200 to 500 kilometers southeast of Melbourne. Most of East Gippsland's population lives in two major town centers (7). There is an average GP-to-person ratio of 1:1679 in this division; however, due to the seasonal nature of the population (East Gippsland is a popular seaside vacation area), the ratio can vary from 1:954 to 1:4753 (7).

General Practice Data and Outcome-Based Funding

Eighty-six percent of Australians visit their doctor at least once a year, giving GPs a principal role in the management of health concerns and, consequently, overall resource spending, including patterns of prescribing, uptake of preventive activities, uptake of other health services, the use of diagnostic imaging services, and referrals to specialists (5). General practice divisions have been identified as an organizational structure that will likely effect improvement of health outcomes. Divisions are required to identify key areas in which outcomes can be measured over time; with the growing recognition of the importance of decision support systems in measuring these outcomes, the setting of general practice divisions is an important one.

Funding is made available for GP members of divisions to become involved in cooperative activities. A proportion of a division's income, however, is tagged to its ability to demonstrate improvement in previously agreed-upon health outcomes for its population. These outcomes—and, therefore, the income—are information-dependent.

In terms of the role of routine data collection in the general practice sector, the collection of morbidity data or practice patterns is currently not at all systematic. In Australia, in contrast to the United Kingdom and the United States, there is an unfortunate lack of reliable morbidity data collected at a population level and inclusive of any useful geospatial variables such as address, postcode, or statistical local areas. Each practice chooses how or when to computerize its business, what data it collects, and how the information is used. To date, there has also been a lack of information on the outcomes of GPs' activities, which can partially be attributed to a lack of data collection systems and technological approaches to advancing information for a health outcome decision-making system. The development of this GIS sought to redress some of these past limitations.

Project Methodology

Briefly, the phases of the project consisted of determining information needs, collecting data, implementing the system, delivering it, and evaluating it. The methods and data sources for this project were closely aligned to the needs and future directions of the divisions in their provision of clinical and preventive general practice services to their communities.

Data Collection

The information needs of the two divisions were determined early, relative to the scope of the project and dependant on whether the data collections had a geospatial variable included within their data structure. Divisions identified the important areas of decision-making and these were linked to potential sources of available data. Some of these data are routinely collected by leading health agencies at national and state levels, but more local data needed to be gathered to provide a more complete picture.

The digital map base of Victoria was provided by Land Victoria. Demographic data (country of origin, age, sex, and income) came from the 1996 Population and Housing Census (6). Hospital admissions data were obtained from the state government's hospital inpatient database, known as the Victorian Inpatient Minimum Dataset (8). One of the most important priorities that divisions of general practice identified is immunization coverage of young children, so data on coverage rates came from a national population-based immunization register (9).

Redressing the Gaps in Data Availability

Data were attainable on the population within the divisions, but very little information was available on the general practices themselves. This gap in data availability was partially redressed through questionnaires administered to each practice location. These questionnaires collected information relating to types of data held by general practices (electronic or paper-based patient health records, availability of data summaries, knowledge of peak service times) and questions that helped build a picture of the size of the practice by number of staff and patients seen, other co-located services, and other relevant data such as the distances patients traveled to see their doctors.

Developing the System for Divisional Implementation

The increasing emergence and widespread uptake of communication technologies in Australia was considered in the preparation for presentation of the GIS prototype to the divisions. The team chose the Internet as the optimum medium for the delivery and placement of the product. For the GIS software itself, ArcExplorer (ESRI, Redlands, CA; http://www.esri.com) was chosen, because it can perform elementary queries and provide good quality display, desirable by the divisions. While this package does not have the full analytical capabilities of other GIS packages, the selection of user-friendly software was a high priority. Because the pilot divisions already have access to the Internet, software costs and the acquisition of additional hardware were eliminated. This project did involve posting confidential information. To address this concern (one not unique to working with the Internet), a password-protected Web site (http://www.sli.unimelb.edu.au/gdv/gdv_health.html) was used. The password system allows only the pilot divisions to access the confidential information.

Figure 2 shows the model of integration of databases in the GIS for GPs. All the databases have been integrated into the system through common GIS operations such as tabular linking and address geocoding. Common identifiers like postcode boundaries and divisional boundaries permit the integration of all data into the system.

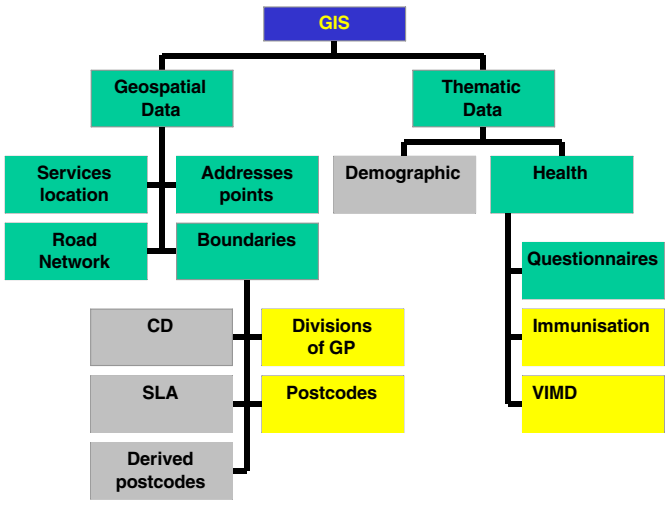

Figure 2 Model of integration of databases in the GIS for General Practice project.

Project Outcomes

Queries

The possibilities for making queries and analysis are many. An example of a two-stage query is as follows:

1. "Show me the postcode areas in the northwest Melbourne division where fewer than 80% of children between 15 and 20 months of age are fully immunized" (corresponding to the Australian Childhood Immunisation Schedule). The postcodes are both tabled and highlighted (Figure 3).
2. "What immunization providers are located in these postcodes?" This reveals all family doctors, community health centers, and maternal and child health nurses in the area who may be targeted for inclusion in immunization initiatives (Figure 4).

Ideally, all the datasets would have boundaries that articulated, making it simpler to integrate the data. Because this is not the case, a new query must be formulated for each of the themes. Spatial queries can be performed using the information tool (***i***) in each of the layers.

Training and Evaluation

The end stages of the project involved providing training and education to the two di-

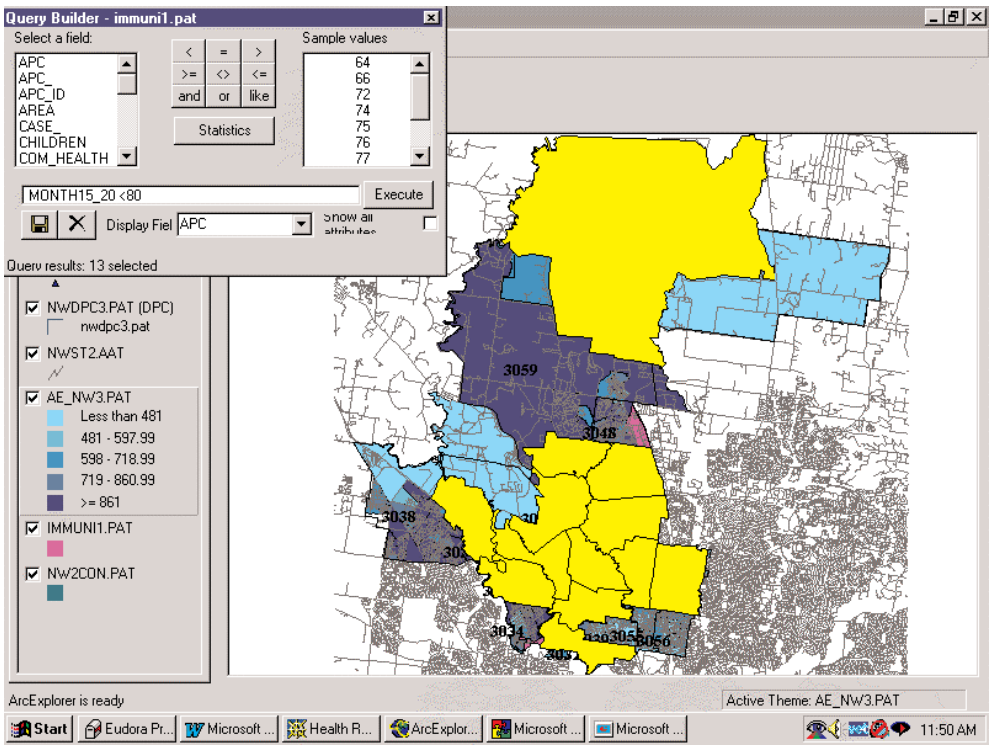

Figure 3 Postcode areas in northwest Melbourne division where fewer than 80% of children between 15 and 20 months of age are fully immunized.

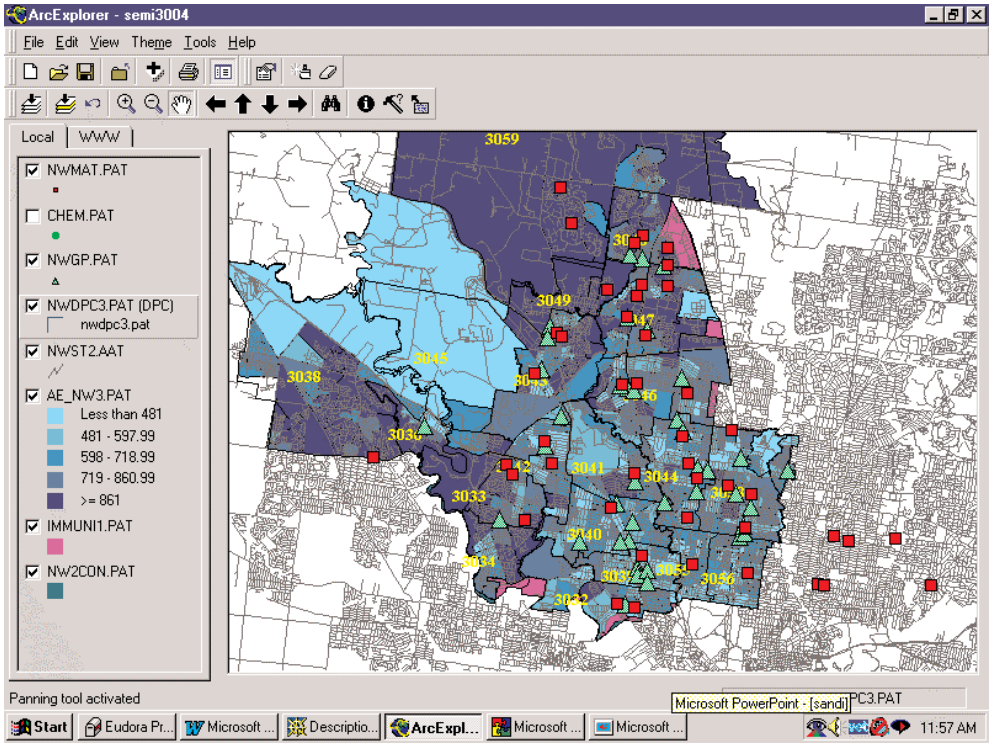

Figure 4 Immunization providers located in the postcodes with low immunization rates.

visions because divisional staff have no prior experience with GIS or geospatial data. The training provided some basic theory, and there were practical sessions on the use of spatial information systems, geospatial data, introduction to ArcExplorer, basic querying skills, and spatial data visualization. While it is important to consider that the technology is being adopted by the organization rather than individual users, consideration needs to be given to the variation in the ability and familiarity of divisional staff with information technology and whether this affects how they use the database. Divisional staff will use the GIS according to their job role within the organization. Program planners, administration support, and executive staff, for example, may make varying uses of the database.

For the 12 months after the GIS is implemented, an evaluation is planned of the ways in which the technology is adapted and reinvented to meet divisional needs. The timeline of the evaluation takes critical planning processes of the divisions into consideration and ensures that the evaluation occurs within the lifespan of the data in the GIS. Qualitative and quantitative data collection methods will be used, such as in-depth interviews with staff and a systematic review of documents and administrative records that incorporate data or use the GIS' capabilities. Of particular interest will be determining what new things the GIS enables the divisions to do, as well as how it helps them perform activities in which they were already involved.

Because the adoption of GIS in the primary health sector is a relatively recent phenomenon, there are relatively few examples of adoption of the technology and, conse-

quently, a limited amount of experience to support claims that GIS implementation means improved information processing and more informed decision-making. Results of the evaluation will be used to inform the development of future information-based decision support technology within the divisions-of-general-practice environment.

Conclusions

The GIS for General Practice study was undertaken to develop a methodology for the provision of a GIS to a particular group of providers of primary health care, and has achieved its aims. The research has highlighted a number of constraints in the development of a GIS for the health sector, the major challenge being the variety of geographic classifications that have been used for health data over the last decade (including numerous versions of regional and subregional classifications used by national and state authorities). There are also widespread differences in data collection methods, data quality, and data access.

A relatively underdeveloped technological infrastructure within general practice in Victoria minimizes access to the Internet and information systems in general, though current trends in the acquisition of computers will go some way to overcoming this constraint.

The Victorian government's policy to make available geospatial data to all Victorians (10) details its intention to face the information age in the 21st century. Other initiatives in the state of Victoria this year include the state Department of Human Services' commitment to drawing up a GIS for Health Strategy to support spatial information systems and improvement of decision-making by health planners (11), and the development of an Australian Research Council-funded project to develop a GIS for Health Research Strategy as well.

Until recently, GIS in health has depended on quantification methods of monitoring and measuring the population. Statistical surveys, epidemiological assessments, evaluations, and health outcomes are currently a central influence on policy, planning, and resource allocation. If there is a desire to study the geography of health rather than the geography of disease (12), consideration needs also to be given to ways in which qualitative health data—which include lay perceptions of health and illness and the "lived," or socially experienced, dimension of health (13)—can be incorporated into a GIS framework.

The research team that developed the GIS for General Practice prototype is not the end user. The end users, the divisional teams, have not previously had experience using information systems to help them make decisions. They are also under a great deal of pressure to change how they make decisions, and change what techniques they use in their decision-making. The final evaluation of this project will be testimony to the ultimate success of the GIS for General Practice product, but the outcomes of the actual creation process are already tangible. It is hoped that these initiatives will further the use of GIS technology in the health sector in Australian states and territories.

Acknowledgments

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